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Thesis

THE BASES OF LEARNING

Submitted by

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(B.S., Tufts, 1923)

In partial fulfilment of requirements for
the degree of Master of Arts

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INTRODUCTION

To psychology belongs the peculiar distinction of being everybody's science. For since every human being has a mind, the science which deals with human phenomena must have a peculiarly intimate and constant appeal. It is true that we all deal with physics and chemistry, biology and astronomy and some of the other sciences, to some extent. But psychology is particularly distinguished as that science whose facts and laws we are perpetually exhibiting. We may close our eyes and shut out most of the physical world, but there is no such door we can close on the mental world.

Whether we will or no, then, we are all interested in the science of psychology. We may not yet have organized our knowledge into anything like a true science and we may still be unaware of how cause and effect operate to produce our thoughts and feelings, our ambitions and sorrows, but in spite of this we are all at least amateur psychologists. For since our minds are the only means we possess whereby to gain experience, psychology is our chief concern. Do we succeed or fail in some cherished undertaking? Can we make or keep friends, or do we find ourselves at middle age bereft of agreeable companions? It is because we have applied our psychological information well or badly.

It would seem then that a scientific study of this field of human interest would be extremely profitable. We need to do more than "muddle thru" our psychological problems; we need to know the most intricate workings of the mental mechanism in order not only to save the time and energy we now

waste in guesswork, but also to direct our ambitions and plans in the most profitable manner possible. "Knowledge is power" said Francis Bacon,--"power for the benefit and use of men." The study of psychology furnishes just such power; it is the most profitable investment a man can make.

Psychology is commonly defined as the science of mind or of consciousness or of human experience. Such definitions, while admirable for their brevity and compactness do not explain the matter sufficiently nor do they sharpen our curiosity to investigate any further. All these terms,--mind, consciousness and experience,--are too vague and general. Besides, they lead us to suppose that because each man has a mind, a consciousness, and an experience, he has therefore a scientific acquaintance with them. This is of course, not so. In addition, many of our experiences flatly contradict each other and so make it impossible for any scientific value to be attached to them. For example, the motto, "Too many cooks spoil the broth" is opposed by the maxim, "In the multitude of councilors there is safety". Psychology is not merely a nodding acquaintance with mind or experience; it is rather a study of how mind develops and under what conditions it prospers or decays; of how consciousness originates, as well as why it is often alternately clear and cloudy, and so on.

From this it is apparent that no tabloid definition of psychology can be supplied. The field is too large and complex to be passed over so briefly; nevertheless, we may say that psychology deals with all such things as thinking, feeling, acting, memorizing, forgetting, intending and resolving,

with how things get known by us and how they get organized into our available knowledge. It deals with pleasure and discomfort, fear and joy and with all the host of emotions and sentiments, with walking and running, fatigue and sleep, honesty and treachery, skill and imbecility.

In brief, Psychology is the Science of human activities in its largest and most pervasive sense. For mind in its last analysis is action, the action of human beings in the midst of their environment. Some of this action we call sense-perception, some we call thinking, some we call feeling, some we call skill, some we call imagination and so on thru a long list of mental powers and functions.

If mind is activity, we might well ask the question, "of what is it the activity?" It would be absurd to reply that, "Mind is the activity of our mind." May we venture to say that mental activity on the physiological side is a combination of physical, chemical and electrical energies developed by the nerves, muscles and glands of the human organism.

Psychology is the science of the how and the why of thinking, feeling and doing and it explains these processes in terms of the dynamos and motors of the human body---its brain, its muscles and its glands. It is not our mind that does our thinking, but it is the sum of our thinkings, feelings, doings that is our mind. And this vast collection of mental activities, this novel, subtle and intricate assemblage of energies is generated by the human body as the result of its immediate contacts with the environment in much the same way as electricity may be generated by a turbine that has been placed in

the midst of a waterfall. In Sherrington's striking words, "Environment drives the brain and the brain drives the rest of the body." When

When, then, we speak of mental mechanisms we mean some apparatus of the body (glands, nerves, muscles) for the purpose of transforming the common energies of nature into the special energies known as mental. A bowl of soapsuds is a mechanism for making bubbles, two sticks of wood are the mechanism for making a fire and a cookstove with a flue and a damper is a mechanism for making biscuits. In the same way the special structures in the body known as the sense organs, brain, glands, muscles, are mechanisms for producing skill, thought, memory, ambition, and the like. For since we always find minds only connected with bodies, we are convinced that these various special bodily structures are essential for the development and integrity of the mind.

This conviction has the finest kind of support. To begin with, as we ascend higher in the scale of life and intelligence, we find an increasingly higher and more complex nervous organization. Secondly, brain defects such as decay and wounds, give rise to mental incapacities. Thirdly, poisons affecting the body also impair the mind. Fourthly, fatigue of the body gradually dulls the mental capacities. Fifthly, the "speed of thought" has been identified with the speed of the nervous current. And so on throughout an extended list of scientific discoveries which reveal to us many of the intimate secrets of our physical and mental existence.

Let it not be supposed, however, that the term "mental

Mechanism" is at all materialistic. Materialism identifies matter and mind completely while mechanistic psychology calls mind activity. The difference between the two conceptions is profound. Materialism denies the existence of mind while mechanistic psychology merely seeks to explain it by the most obvious and convenient means which ten centuries of patient scientific investigation have placed at our disposal. Let us then at once turn to an examination of how the mechanisms of the brain serve to transform the common energies of nature into the special energies of mind.

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THE PHYSIOLOGICAL BASIS of the PSYCHOLOGY of LEARNING

CHAPTER I

THE STRUCTURE and FUNCTION of the NERVOUS SYSTEM

The brain is the central telephone exchange which regulates both vital and mental functions. The brain is not the source of either life or thought, but rather the instrument by which the organization of vital and mental functions is finally perfected. The central office of a telephone system does not originate the conversation of the subscribers, but merely furnishes the interconnections. Likewise, the brain is the instrument whereby man's many energies may be guided and combined and brought into harmonious and profitable relations with one another. Every cell of the body is alive and brimming over with chemical and electrical energy, every cell of the body is also vaguely or blindly sentient, seeking in some way to grow, to persevere, and to reproduce; but without the brain to render mutually democratic all of these myriad striving units, the body would be chaos, lacking that unification and direction which go by the name of mind. So let us examine one of the elements of this communicating mechanism in detail.

No matter how intricate a piece of tapestry may be, if you unravel it, it will be found to be made of many colored threads, some long and some short, but all of them nevertheless threads. Such finally indivisible parts are called the

THE PHYSIOLOGICAL BASIS OF THE PSYCHOLOGICAL

CHAPTER I

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The brain is the central organ of the nervous system. It is the seat of the mind, and the source of all our thoughts and feelings. The brain is made up of billions of nerve cells, called neurons, which are connected by a network of fibers. These fibers carry electrical impulses from one part of the brain to another, and from the brain to the rest of the body. The brain is also the seat of the emotions, and the source of all our feelings. The brain is the most important organ of the human body, and it is the source of all our thoughts and feelings. The brain is the seat of the mind, and the source of all our thoughts and feelings. The brain is made up of billions of nerve cells, called neurons, which are connected by a network of fibers. These fibers carry electrical impulses from one part of the brain to another, and from the brain to the rest of the body. The brain is also the seat of the emotions, and the source of all our feelings. The brain is the most important organ of the human body, and it is the source of all our thoughts and feelings.

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structural units of the tapestry. Similarly if the central nervous system were to be analyzed, we should be able to indicate and isolate its structural units in the same manner. Owing to their extreme smallness, these tiniest parts of the nervous system cannot be isolated by hand; but with the aid of a microscope they can be readily seen in all their minute detail. Such structural units of the nervous system are called neurones.

The typical neurone is best described as a long white fiber, somewhere along the course of which a roundish gray mass, the nerve cell body, is located. Physiologists regard the cell body as the more important, since it is the nutrition center of the neurone; but for psychology the fiber along which the nervous impulse passes is the more highly significant part. If the nucleus of the cell body dies or is removed, the whole cell and the fiber die and are forever lost to the body; but if the fiber is only injured or cut, it will usually grow out again. Such growth is accomplished by the very delicate sheaths which surround the fibers serving both to nourish and to insulate it. What is popularly called a "nerve" is a cable composed of thousands of these tiny fibers. Each neurone fiber is insulated by its two sheaths called the myelin sheath and the neurilemma.

It is customary to regard each neurone as structurally distinct from all the rest, but functionally it is regarded as a part of a mechanism for transmitting impulses. The neurone fibers arborize at each end. One such set of terminations is called the dendrites and the other the end-brush.

This brings us to the first law of nervous activity which is: the nervous impulses always travel from the dendrites down the fiber to the end-brush. This direction is irreversible unless the nerve be taken out of the body to be experimented upon in the laboratory. Obviously then, all sense organs must be connected with dendrites. The impulse follows up the fiber, through the nerve cell body, along the remainder of the nerve fiber, (called the axone), to the end-brush where that particular neurone ends. But at that point another neurone begins, for the end-brush of the first neurone interlaces with the dendrites of the second, and across this tiny but actual gap the impulse must leap, and so on to the hundredth, if need be, until the terminal end-brush is reached.

The speed of the nervous impulse is, according to the most refined methods of measurement, 123 meters per second. But this rate holds only for the single neurone. For the gap between the neurones, called the synapse, often retards the passage of the impulse. Retardation is caused by doubt, deliberation, sleep, and anaesthetics. Accordingly, we may state the second law of nervous activity: all retardation of the nervous impulse occurs at the synapses.

The pathway we have just been describing, involving sense organ, nerve, and muscle, is called a reflex arc and is the functional unit of the nervous system. All mental activity involves such reflex arcs. The simplest arcs are connected with what are called simple reflex action, such as winking, and are absolutely automatic. More complex nervous arcs are involved in instinct, still more complex in learning, and most

complex of all, sometimes involving thousands of nervous elements, in our intellectual planning and deliberation.

While all neurones are of the same substance chemically and microscopically, they have not all the same functions. Those which lie entirely within the brain or spinal cord and connect there with the end-brushes of the receptor neurones are called conductors; while those which reach out their long axones tipped with end-brushes to connect with muscles and glands are called motor or effector neurones. A reflex arc is therefore made up of receptor, conductor, and effector fibers. The brain is made up almost wholly of connector fibers, most of which are relatively short. This means that within the brain there are millions of synapses, from which it also follows that most delayed action takes place at the synapses within the brain.

We have all seen people so completely surprised by some event that they seem momentarily to be without a mind. This illustrates a third important law of nervous activity: i.e., when a reflex pathway has been too strongly excited, it is incapable of a second excitation within its own period of recovery. This period is called the "refractory period".

A fourth law of nervous activity is the law of summation; i.e., if several very weak stimulations be given to a sense organ, none of which are capable of producing a nervous discharge, these stimulations will, if repeated sufficiently, finally sum up into a full excitation. We may not notice the first jingle of the telephone bell, especially if we are pre-occupied, but prolonged jingling of the bell will finally be

noticed. It is likewise this law which explains why a very dull person may require many hints from his lady love that his visits are not desired or his ambitions reciprocated.

A fifth and final law may now be stated; it is the law of the final common path. There are far more connector than receptor fibers in the body, and far more receptors than effectors. This would imply that unless several receptor and connector fibers finally connect with the dendrites of one motor fiber, there would be no means provided for those fibers to produce reflex action. No such difficulty is present, for: the use of one motor fiber by several receptor fibers is universal, and the motor neurones of the chain is called the final common path. The law of the final common path is illustrated in every case in which different stimuli call forth the same responses. Pepper, lint, and dust all make us sneeze (an identical response), The law has far reaching applications. The Greeks called all foreigners "barbarians". We ourselves may detect the working of this law even every time we use a common noun in speaking. For the words, "tree", "horse", for example, are employed not merely to designate one such object, but many and various ones; and this means that many different sensory and connector neurones have been functionally united to one final common motor pathway leading to the speech mechanism. Obviously the more general and abstract terms of speech, such as "virtue", "wisdom", have had a similar origin. All scientific laws by which natural phenomena are classified and unified owe their existence to the principle of the final common path.

The nervous system has always been spoken of as an instrument for communicating impulses and transforming energy. We may now make the statement that the nervous system is a mechanism for the release of energy in response to sensory stimulation. The reflex arc then becomes an instrument for reflex response. Dust in the eye causes it to wink (a muscular response). The postman's whistle stimulates our ears, and we rise and walk (muscular response) to the door. The fire-bell clangs (auditory stimulus) and the man who forgot to renew his fire insurance (blocked at the synapses) looks startled and gets a rise of blood pressure. And so on with all our mental activities.

It is obvious from the foregoing that since all mental activity involves such an expenditure of energy, sensation and thought are costly to maintain.

CHAPTER II

THE FIRST THINGS WE LEARN TO DO

The mental life of man has been appropriately called one long learning process. From the first breath we draw until the day of our death we are forever engaged in accumulating experiences of one sort or another, and we subsequently employ them whether consciously or otherwise. Every experience also teaches us and molds us, until by middle age we are one great mass of habit, bias and proclivity--the accumulation and inertia of previous years. "I am part of all that I have met", says Tennyson, referring to the fact that each man is indelibly stamped with the seal of his many environments.

The learning process of life starts long before birth. As early as the second week of embryonic life evidences of the nervous system are present. In fact, no other permanent part of the body is so clearly marked at this time. The tiny organism exhibits a groove along one side of its surface, and this ultimately becomes the spinal canal and the brain ventricles. The groove deepens; the side layers overgrow and meet at the top; and the nervous system has begun its existence. About this canal nerve cell bodies begin to form and they will later become the receptors and conductors of stimulation. These elementary nerves, which look very much like young tadpoles with an extremely long tail, are called neuroblast. At the same time that these are being formed, miniature structures which will eventually become the muscles of

THE NERVOUS SYSTEM

The nervous system of man has been systematically called the central nervous system, from the fact that the brain and spinal cord are its main parts. The system is composed of the brain, spinal cord, and nerves. The brain is the seat of the mind, and the spinal cord and nerves are the channels of communication between the brain and the rest of the body. The system is divided into the central nervous system, which includes the brain and spinal cord, and the peripheral nervous system, which includes the nerves. The central nervous system is the seat of the mind, and the peripheral nervous system is the seat of the senses. The system is also divided into the somatic nervous system, which controls the voluntary muscles, and the autonomic nervous system, which controls the involuntary muscles. The system is also divided into the sympathetic nervous system, which is the part of the autonomic nervous system that is responsible for the fight or flight response, and the parasympathetic nervous system, which is the part of the autonomic nervous system that is responsible for the rest and digest response. The system is also divided into the sensory nervous system, which is responsible for the reception of sensory information, and the motor nervous system, which is responsible for the execution of motor commands. The system is also divided into the afferent nervous system, which carries sensory information from the periphery to the brain, and the efferent nervous system, which carries motor commands from the brain to the periphery. The system is also divided into the somatic nervous system, which controls the voluntary muscles, and the autonomic nervous system, which controls the involuntary muscles. The system is also divided into the sympathetic nervous system, which is the part of the autonomic nervous system that is responsible for the fight or flight response, and the parasympathetic nervous system, which is the part of the autonomic nervous system that is responsible for the rest and digest response. The system is also divided into the sensory nervous system, which is responsible for the reception of sensory information, and the motor nervous system, which is responsible for the execution of motor commands. The system is also divided into the afferent nervous system, which carries sensory information from the periphery to the brain, and the efferent nervous system, which carries motor commands from the brain to the periphery.

locomotion are developing just outside the elementary nervous system. These primitive muscle structures are called myotomes.

Tendrils from those neuromeres whose destiny it is to become motor nerves grow toward the muscles and become attached to them. As the embryo enlarges, the myotomes migrate to all parts of the body trailing their nerve fibers, so to speak, behind them. In this manner all the muscles become connected with the central nervous system. Simultaneously with this development these neuromeres which are to perform the function of sensory or receptor nerves send out fine fiber-like processes from the region of the spinal cord into all the surrounding structures, and become themselves modified into some sense organ or become attached to a sense organ. However, the mechanism for reflex action, feeling, or sensation is not yet perfected. For while the sensory and motor nerves are all more or less in place, there is no functional connection between them; the disturbance in a sensory fiber has never been transmitted to a motor fiber. Between these two fibers in the cord a network of connector or association fibers must first develop; and a nervous impulse starting at a sense organ must then be shot up the sensory nerve, across the connector fiber, and down the full length of the motor pathway to contract the muscle at its end before the first rudiments of mental activity can be said to be evident. And all this establishment of reflex action, this tuning up of the nervous system for the communicating of impulses and the transformation of energy, has to be LEARNED. Each cell of the

nervous system has to be stimulated again and again before it finally passes on the impulse to its neighbor cell with clarity and precision. Those persons in whom such a tuning-up process is either wanting or altogether blocked or hindered from advancing at its normal rate, we call either idiots, imbeciles, feeble-minded people, or mental defectives; those in whom it is ultra-rapid, we call geniuses.

Let us now consider how the newly-born infant acquires some of its earliest habits and abilities; first of all let us see how he learns to breathe.

How We Learn to Breathe.

Breathing seems to us such a natural, inevitable, and instinctive activity, that we are almost ready to protest that there was never a time when we did not know how to do it. But in spite of its present automatic and continuous character, breathing had a beginning. The mechanism had once to be started going. How did this novel activity commence?

Of all the profound changes which birth involves, one of the most important is often the change in temperature. The change from the mother's body to the air of the room is often a drop of from twenty to twenty-five degrees. Such difference in temperature would produce many subtle alterations in the adult, no matter how much he may have had to do with capricious climates. How much more must it affect the newly-born child. Furthermore, embryonic life is semi-aquatic without light or air to affect growth. These two

changes then,--the great drop in temperature and the novel experience of being surrounded with air,--in a word, the shock of being plunged into a different medium and being enveloped by new pressures,--are the stimuli to breathing. That the change is violent is betokened by the cry of the newly born, a cry none the less portentous because it is so welcome to those who assist and befriend birth.

However, sometimes even the drop in temperature and the air pressure are insufficient to evoke this symbolic cry with which normal breathing originates. The officiating physician often holds the baby up by the feet and slaps it smartly on the buttocks in order, by forcing the blood into the chest, to produce a temporary congestion there. This method is highly successful. The pressure of the accumulating blood is too much for the child to endure passively; to relieve it, he spasmodically inhales once, twice, and again, and his breathing has begun. In this manner, by responding to stimulation with muscular activity and solely by means of the spinal cord pathways, every child born living learns to breathe. Ever thereafter, as long as life endures, the faithful phrenic nerve, the fibers of which originate at the upper part of the spinal cord, lifts and lowers the diaphragm in ceaseless rhythm. Although breathing is chiefly a physiological phenomenon and concerned much more with life than with mind, yet, since all emotional disturbances and many defects of speech are registered in the breathing, its importance for psychology is at once manifest.

How We Learn to Swallow.

We learn to swallow by a slightly more elaborate mechanism than is involved in breathing. The oesophagus down which our food travels to the stomach is physiologically a series of elastic, muscular rings called sphinctor muscles. Indeed, the whole alimentary canal is a series of such ring muscles. Before birth none of these muscles have ever contracted in coordination with one another.

The first feeding of the infant is by means of liquid food. The first drops of this fluid are allowed to run into the infant's mouth, its head and body being inclined so as to allow gravity to play a part in the feeding process. When the first drop reaches the throat, it strikes (stimulates) the uppermost ring of the muscles of the oesophagus. This ring contracts, and with the influence of gravity, forces the milk further down the oesophagus. But all along the tube, the muscular rings are consecutively stimulated to contract by the presence of the falling fluid and one after another of these rings shuts and opens again. A wave-like succession of contractions is thus formed, the upper rings which first contracted being the first to expand and to be ready for the second drop of milk which is already there to be swallowed.

These muscular rings of the oesophagus, however, do not act singly, but together. How is this co-ordination accomplished? A slightly new type of nervous activity is involved in learning to swallow. There are not only sensory and motor nerves for each ring separately, but there are also sensory

and motor pathways leading from ring to ring. And the spinal mechanism is so perfected at birth that the stimulation and contraction of one of the upper rings hinders the simultaneous contraction of the rings immediately below it. However, so nice is the nervous arrangement and so precise do the function of synapse and neurone become with practice, that the presence of food in the upper part of the oesophagus automatically starts a wave of contractions down the whole tube. This is what happens when we swallow without food being present. Were this not the case, we should never be able to eat and swallow while lying down or while standing on our heads. For in the adult, swallowing is independent of the posture of the body. Such an automatic succession of contractions is called a chain reflex. When this mechanism in the alimentary canal is reversed, we have vomiting, nausea, and other distressing results.

How We Learn to Grasp.

One of the most useful, persistent, and earliest of the acquired tendencies we possess is the grasping reflex. It consists of a propensity on the part of the infant to close its hand about any suitable object tenaciously for ten or fifteen seconds even if it is lifted so high that the infant is suspended in the air. Whether this instinctive action is a relic of the tree life of our simian ancestry is a question too difficult to be decided here. The point for us is that it is a purely spinal reflex, and does not involve the brain at all. Let us see how such a tendency begins and matures in the human

being.

There are three causes which contribute to the strength of the infant's grasp. In the first place, flexion is always more powerful and complete than extension. There are more and stronger muscles in the body for the purpose of flexion than for any other purpose. The calf muscles and the biceps are typical examples of this flexion mechanism. Moreover, the adult can exert much more force by closing his hand than he can by opening it. Grasping or flexion, then, is naturally one of the strongest actions of which we are capable.

In the second place, every muscle of the body upon contraction stimulates tiny sense-organs within it which are connected by a sensory or receptor nerve with the central nervous system. This stimulation caused by the muscles' own contraction is transmitted to the spinal cord where it, of course, seeks an outlet. What outlet is provided for it? The outlet of the motor pathway already carrying the impulse which originally caused the muscle to contract is open, and it is into this channel that the new stimulation (that from the sense-organs within the muscle itself) is directed. The astonishing result is that the muscle by this means automatically reinforces its own contraction. This tremendously striking and novel phenomenon is called the circular reflex. When, then, the infant's hand grasps the bar to hold it, his own gripping accentuates the tenacity with which the bar is held.

However, we have not yet told how this grasping reflex originated or why it developed in preference to any other in-

instinctive action which the child might have manifested. Nevertheless, the cue to this mystery is not hard to find, for, as we have mentioned before, the flexion mechanism of the body muscles is naturally more powerful than the system of extensors and this advantage is signified even in the appearance of certain parts of the body. The hand of the embryo, for example, assumes as it develops a flexed form,---the fingers are curved on themselves so that the finger tips nearly touch the palm. Not till the baby is born do the hands ever stretch out or flatten. The momentum of the posture gained in embryonic life is never thereafter lost. This is why we always hold our hands in a more or less gracefully curved position. It is also why we cannot hold the fingers stretched out stiffly for more than a few moments unsupported unless we give our individual attention to it.

Now such a flexed posture of the hand brings with it certain all-important consequences. For the finger tips, it must be remembered, are sensitive surfaces, and the palm is likewise full of sense organs to which sensory nerves have already migrated from the spinal cord. Likewise, the muscles of the fingers and palm have been supplied with motor nerves ever since these muscles were myotomes. So that if some random movement or jar which disturbs the embryo causes the finger tips to touch the palm of the hand, a stimulation will be given which will be carried by the sensory nerve up to the cord, by the conductor fibers across the cord, and by motor fibers down from the cord again to the muscles of the palm and fin-

gers, causing flexion or clenching of the hand. Such random stimulations are, indeed, numerous; and every time they occur, the embryo literally practices the grasping reflex. With the practice the reflex becomes stronger, so that by the time of birth, the infant has developed a remarkably strong tendency to hold fast to anything that is placed between his palm and finger tips. Such a reflex also develops the sense of touch in the child, for just as motor response is essential to sensation and feeling, so are sensation and feeling necessary results of motor responses.

We have, therefore, three causes of the strength and tenacity of the grasping reflex. The first is the great number and strength of the flexor muscles, the second is the circular reflex, and the third is the pre-natal practicing by which the reflex is developed and perfected. Now let us look at some of the relationships between this reflex and the conscious intelligent life of the adult individual.

To begin with, children born without a well-developed grasping reflex are usually both mentally and physically inferior to other children. And they are mentally inferior for a very definite reason; for since it is by means of clutching and pulling things about that children learn the shapes and sizes of objects, it follows that the fewer things a child handles and manipulates, the less does he learn. The hand is par excellence the mechanism by which young and old explore the environment and find out what it is made of. Where this mechanism is feeble or undeveloped, such self-education is seriously delayed and thwarted.

In the second place, our language is full of words which indicate that closing or clenching of the hand is a highly important activity in our dealings of man to man. Our word "pugnacity" is derived from the Latin "pugna", a fist, that is, a tightly closed fist, a fully perfected grasping reflex. Then there are such expressions as grabbing, snatching, laying violent hands upon somebody, which all refer to this fundamental activity. Rapacity is in all its modifications derived from grasping. We likewise refer to this same reflex activity when we speak of the grasping miser, the beggar with the itching palm or the close-fisted landlord.

Furthermore, a great variety of expressions which describe physical possession or refer to the act of retaining what we have earned or stolen have their roots in the grasping reflex. To illustrate this, we may mention all such words and phrases as: grapple, grab, keep hold of, fasten upon and get into our hands. The legal term, "mortmain" (dead hand), refers to property so tenaciously held as to be inseparable from its owner; "the bird in the hand that is worth two in the bush" signifies firm clutching and safe possession; while the common expression, "he lost his grip" likewise reflects the great importance of the grasping reflex in adult life.

Even here we are not at the end of our list of derivations. Many terms signify authority; whether they mean management, government, despotism or tyranny, they are fundamentally the grasping reflex. Witness such expressions as: gain the upper hand, pull the strings, wield the scepter, rule with an iron

hand, and the like.

Many of our tools have more than a superficial resemblance to the shape and function of the hand and fingers. Such are: tongs, forceps, pincers, and pliers. In addition to this, many of our purely intellectual operations are based on our manual powers. Apprehension is catching on; and comprehension is seizing for the purpose of estimating. Then we have such words as: emancipation, mandate, manipulate, manufacture; also such expressions as: right hand of fellowship (Unitarian) and intellectual grasp; each and all of these have their genesis in the powers and activities of the hand. The grasping reflex is indeed, one of the most fundamental, significant, and far-reaching activities which the human organism manifests.

How We Learn to Fixate Objects.

Another of the first things we learn to do is to fixate objects with our eyes. This special ability is not native, but acquired, and the process by which it is finally achieved is both curious and fascinating. At first the eye of the infant is not yet fully developed. The spot of clearest vision in adults, the fovea, is unable in the newly born to see anything at all. The rest of the infant's eye at this time is unable to stand any intense light, and in fact, registers pain when stimulated to any great degree. Only one part of the eye is able to bear light, or stimulation, without pain, and that part is, strange to say, the fovea itself, which being as yet undeveloped, has neither the power to see brightness, or light, nor yet to feel any discomfort from it.

A light streams diagonally into the baby's eye and stim-

ulates it, producing thereby discomfort. The baby at once turns his head or his eyes or both, this way and that, seeking to get rid of the light, until, by chance, the light is brought to stream directly on the fovea, whereupon he ceases his squirming and gazes directly and placidly at it. But he does not thereby see it as we see it. He has merely succeeded in getting the light beam to bear upon the sightless part of his eye, that is, to cease to annoy him. Again and again this same performance takes place so that gradually he learns to turn his head directly to face the light the moment it strikes his eye from any angle. Step by step, of course, this fovea has been developing a sensitive seeing surface, and so, by the time sight is strengthened, he is able to make his eyes bear directly upon the stimulus to vision. It is thus by withdrawing from the light in the first place that we later learn to use the eye to best advantage. The adult turns his gaze not only fully upon whatever he wishes to read and examine, but also upon the source of every sound, smell and movement which attracts him. This turning of the eye upon the stimulus, moreover, is what is ordinarily meant by the word "attention".

CHAPTER III

HOW WE LEARN the PERCEPTION of SPACE

The meaning of the word "perception" can best be brought out by an illustration. If something is held up before your eyes and all you see is the color, you have only a simple perception; but if you say, "It's an orange", or "It's a sheet of paper", you have, on the contrary, a more complex perception. Likewise, if you experience a sharp skin pain, you have again only a sensation; whereas, if you cry out, "That mosquito bit me again!" you have not only sensed but perceived. In other words, perception involves "acquaintance with" and "knowledge about" the stimulus which produces the sensation. Perception is thus equivalent to understanding, comprehension, recognition; in a word, equivalent to learning. Coming down to the fine point, every compound name that we give to our sensations implies some form of perception. The terms, "bright red", "lukewarm", "lemon sour", are one and all discriminative, implying perception and sensation.

And since the naming of a stimulus is wholly an adult characteristic, infants know neither the name, the source, nor the meaning of their experiences until they later learn about them. Perhaps the lower creatures who have neither language nor a span of life adequate to acquire knowledge of the relations of things, live in a world of pure sensation. Herbart states, "Entirely of themselves, and without the slightest action, concepts become combined so far as they are not hindered by an arrest. Hence, for a child (and why

not for an animal?) there are no individual objects as yet but entire surroundings which, even as regards space relations, only become separated in successive representations".

We may now go one step further and say that perception not only involves, "acquaintance with" and "knowledge about" the stimulus, but is itself a test about these things. For example, while we may all know something about golf, yet how limited is such a perception in comparison with that of the man who comprehends the following newspaper report:

"Guilmet and Vardon failed to get on on their seconds. Vardon apparently had an easy four but once again slipped up. It was Guilford who won the hole, beginning nicely and winning the cup on his approaching putt."

The same variations in the breadth of perception ability is seen in the comments of those who attend a baseball game or a symphony concert. In fact, a man's perceptions reveal the breadth and depth of his experiences. To say, "I perceive that--" is equivalent to declaring, "This much I know and no more."

One of our most important mental activities is the perception of space. Our knowledge of extension and limitation in all directions is essential to the maintenance of life. By means of this knowledge we calculate nearly all of our important ventures. The journey we propose, the bringing of food to our mouths, "swatting flies", etc. Were we lacking this power we might starve to death within easy reach of food, mistaking a foot for a mile. Thus it has a survival value for

the human organism in all of its important dealings with the environment.

The ability to perceive space relations comes by dint of long training. It is not possessed by the newly born infant as the latter will reach out with equal confidence for the milk bottle and the moon. The first hints, however, of near and far come quite early in life. The infant squirms about in its crib learning that comfort and his position have much to do with each other. He soon begins to explore his own body considering the discovery of his toes a "great find". All this pushing, pulling, stretching, rolling, etc., relates his various stimulations to each other and, too, helps him to discriminate between them. Upon rolling his head to the right, he sees one sort of thing while at the same time losing sight of objects on his left. This starts a faint trace of the meaning of here and there in his mind. Upon looking down upon himself, he gets the notion of near, while looking up, he gets the notion of far away. And so on through a long list of gestures, looks, postures. Voices that are faint mean distance. such relationships require much training and in some cases, are never fully understood. This statement may be readily discovered if you ask an acquaintance to define the words "here", "there", "high", "low", "near", "far"! He will often simply point about him and illustrate rather than define their meaning, and this is equivalent to his confessing that he is still a child when it comes to knowing what space is.

Following are several theories on this point:

The most extreme form of the genetic theory is that of the English Associationist School (Locke, Hume, Hartley, James Mill, and Alexander Bain).

Wundt, seeing that this theory would not work, attempted to improve it by 1. giving more explicit recognition to the principle of creative synthesis; and 2. by postulating a greater variety of the adjuvant sensations which were supposed to enter into the synthesis.

James rejects the Associationist theory, stating that there are but three kinds of theory possible concerning space. 1. Either there is no spatial quality of sensation at all; or 2. there is an extensive quality given immediately in certain particular sensations; or 3. there is a quality produced out of the inward resources of the mind which are not spatial but, when thrown into the spatial become united and orderly. James rejects the first and the third of the theories, accepting the second which is the nativistic theory.

Hermann Lotze has given the best statement of the "psychic stimulus" theory by the use of the term "local sign". Lotze's local sign is, then, not a sensation; it is purely a nervous process initiated by the stimulus to the retina, its specific nature depending upon the locality of the retinal spot stimulated. Thus we have the genetic theory.

We perceive space by means of only four senses; sight, hearing, kinaesthesia, and touch. Smell, warmth, and cold may give us direction, but all other senses are entirely spaceless. For example, pain tells only of location and intensity since there is no difference between the feelings produced by a

round hot object and a square one.

That the skin contributes a large part of our knowledge of space may be shown in several ways. In the first place, a light touch upon the brow is immediately distinguished from a similar touch upon the nose. How is this possible when all the organs of touch are alike? The answer is that the difference in these qualities of touch is due to the different responses we make in each and every case (local sign). The extent of this arousal is not exactly known, but certainly a touch in the ear lobe may be safely conjectured to start an impulse to turn the head in that direction while a touch on the forehead arouses a tendency to withdraw the head so as to enable the eyes to see what is there.

The skin gives not only position but movement and direction as well. A fly crawling across the face acquaints us at once with the order of his going by stimulating with his feet different touch spots on the skin. The fly also gives the notion of speed and distance. Here, then, we have five factors which are essential to space perception,-- position, movement, direction, speed, distance. But the skin alone gives only what is called in geometry two-dimension space, i.e., space in a plane surface. It is not until we come to the senses of movement, hearing, and vision, that we learn what the third dimension is, i.e., distance from the body, to our knowledge of space.

The skin is often a "shifty witness" to our sensations. Two blunt compass points placed near together on the skin are not always recognized as two, unless the part touched has pre-

viously received special education in this respect. In the untrained person who has not yet learned to make the finer distinctions between distance on the skin, compass points placed at the following distances apart will be felt as one single touch.

Region of skin	Distance between points in millimeters
Tip of tongue.....	1
Tip of finger.....	2
Lips (outer surface).....	5
Tip of nose.....	7
Lips (universal surface).....	20
Back of hand.....	32
Forearm and leg.....	40
Breast bone.....	45
Back.....	54
Upper arm and thigh.....	68

The fact that our kinesthetic sensations give us a knowledge of movement makes them of paramount importance for the perception of space. For space means extension in different directions, and every hint we get of extended things is due to our own ability to move. For example, we can rotate our arms in wide circles, and by making all sorts of gyrations with them explore the space about us. Moreover the hand can move over the skin surface, across it and around it in all directions, thereby provoking all manner of skin, joint, tendon, and muscle responses which are coordinated into perceptions of size, length, curvature and so on. It is by this means that the infant learns the rudiments of space while exploring his own body.

The sense of hearing contributes to our perception of space by affording us cues whereby we judge both the distance

TRITON BRAND

of the sound from us and its position with respect to our bodies. It is easy to show that the ears unassisted make many mistakes. If the head is held steadily, while an electric buzzer is sounded at various places nearby, it is found that while to the left and right of the head are judged with an error of from five to ten degrees, all sounds produced directly in front, behind, above, or below the head, are curiously mistaken as to their location. The error is often as much as one hundred and eighty degrees. A sound made exactly in front of a person may be judged to be directly behind him, etc. Several over-confident persons have been known to lose wagers by submitting themselves blindfolded to such a test. The law is that we recognize the position of a sound solely by means of the relative intensity with which it strikes the two ears; hence all sounds that strike the ears with equal force, i.e., those directly above, below, in front of, and behind the head, are frequently misjudged.

Professor Pillsbury writes of the space perceptions of the blind: "For the blind, the auditory perception of space is much more important than for the seeing individual. Not only are they more accurate in their localizations of sound but they use sound to obtain an idea of the space in which they are walking and of the distance of objects. The echo of the footsteps varies with the size and shape of the room. When the boys in a blind assylum were provided with felt slippers, they could not avoid obstacles."

The eyes are the most important of the sense organs from which we learn our perception of space. The two eyes, by foc-

using on the same point and by combining two different pictures of the same object, furnish us with the most reliable cues for depth and solidity. The popular maxim, "Seeing is believing" is thus based on physiological fact.

However, even the single eye can give us a knowledge of position. In visual terms, the word "up" means that a stimulus causes the eye to roll in a certain direction, thereby producing a characteristic kinesthetic sensation that differs significantly from the sensation felt when the eyeballs roll in the direction we call "down". Other qualities of eye and eyelid movement come to mean "right" and "left", "across", "on top of", on through the list of terms which mean space. The eye, however, does not learn by itself. From early infancy we touch and fumble what we see thereby associating movement sensation from the hand and arm with sensations from the eyes.

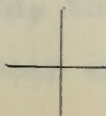
The sum of all this is that we learn to perceive movement by moving ourselves, or by means of strain sensations of muscles about to be moved, although such may not be noticed clearly by us.

A very interesting experiment has been devised to show the truth of this statement. If the arm is laid in a board hung from the ceiling by springs so supple that the slightest pressure will cause the board to be depressed, and if a fine wire lever attached to the end of the board is so pivoted as to make broad excursions at the free end; and if then the person submitting to the experiment, be blindfolded, lays his

arm upon the board and merely thinks "up", "down", "left", etc., he will unconsciously move the lever in various directions showing that even the thought of special relations is bound up with the movements of the arm in space. Were we able to record with equal delicacy and accuracy the behavior of the eyes while we are thinking any space relation, their movements would likewise illustrate the same general principle. Indeed, we often get just such hints from the eyes of people as to where they are looking and what they are thinking about. Coy maidens out walking with their duennas only with difficulty conceal their secret desire to communicate with passers-by.

As we perceive movement, so do we perceive extension in two dimensions. In the case of surfaces, the eye always tends to trace their boundaries. Space perception by the eye is thus accomplished through imitative movement. For example, it takes no more eye movement to perceive a tree two hundred feet high a mile away than to perceive the length of a match held in the hand. In this respect the eye is like a telescope which swings only a small fraction of a degree on its pivot to pass over vigintillian miles of interstellar space.

If the perception of visual space is always accomplished by ocular movement, the question may arise: "How do we perceive such a bit of design as the following cross?"



Obviously our eyes cannot move up and down and sidewise at the same time. If we fixate the intersections of the lines, no matter how attentively you try to keep the gaze riveted there, you will find your eyes constantly tempted to move out along some of the cross-bars to the end and it will be only with the greatest effort that you will be able to inhibit all such wayward tendencies in the eyes.

A very handy and precise term for these imitative movements which aid in space perception has recently been coined. This term is empathy. Sympathy means the tendency to feel with or to share the emotions of animate beings, while empathy means the tendency to imitate any attitude, posture or design. All sympathy is empathy plus emotional response.

In Vernon Lee's little book, "The Beautiful", there occurs an account of empathic response, for he shows that when we say, for example, "The mountain rises", it is only our eyes, chin, and head that are being elevated.

In the same way the traveler who reported that "Just as night was falling, he perceived that the desert stretched many miles to the south", was describing what certain parts of his body were doing at that time. For neither do nights fall nor deserts stretch literally, yet darkening skies feel like descending black canopies, and distance yet to be traversed induces prophetic strains in the tendons.

How do we perceive distance or depth, i.e., the third dimension? To begin with, the lens of the eye automatically changes its shape for near and far objects by means of the

ciliary muscles and the elastic membrane surrounding the lens but it is the lens and ciliary muscles which provide us with the first hint of the third dimension. Moreover, it appears that the lens of the eye has the unique property of being responsive to distance as such.

The second physiological factor is called convergence and involves both eyes. The two eyes move as one. "This can be seen directly in another's eyes. When he looks at a distant object, the white shows about equally on each side; as he looks at an object only a foot away, considerable more white will show on the outside than on the inside of the eyes." Thus they arouse a general motor attitude of reaching out for the object which the whole kinetic system faithfully develops and maintains.

The third physiological factor is called double images or binocular parallax. If you hold up your fist, thumb knuckles toward you six inches from the nose, and then close alternately the right eye and the left, you will observe not only that one eye sees more of one side, and the other eye none of the other side of the fist, but also that the thumb knuckles appear to shift right and left as the eye is opened and closed.

A spot of ink on the thumb knuckles will accentuate this phenomenon. This experiment shows that each eye gets a different picture of the object. Moreover since the two eyes are situated about 2.25 inches apart, they together are able to take in a little more than fifty per cent of round or cylin-

drical objects. Since the difference in the two-eye picture decrease directly as the distance of the object from us, this fact furnishes a valuable subconscious cue for our depth perceptions.

Theoretically, all objects in space not fixated should appear double, but our custom is to ignore these double images, to react as if this were not the case. Following is an experiment to prove this. Hold one index finger five inches from the nose and the other index finger one foot away; now if you fixate the nearer finger, the farther one will appear to double. Contraiwise, if the farther one is fixated, the nearer one is doubled. Besides, the doubled finger is not easy to locate with regard to distance from the eyes, especially if you have someone else hold his fingers in place of yours. The answer to this is, that each finger is a stimulus to vision. The unfixed finger, then, doubles because of the opposite motor tendencies in the eye mechanism. Also the motor activities of convergence and accommodation so dominate the whole kinetic system as to draw off all conscious responses down one final path, the fixation path.

Employing the principle of double images, we are able to make the bird go into his cage. First let the "far away look"

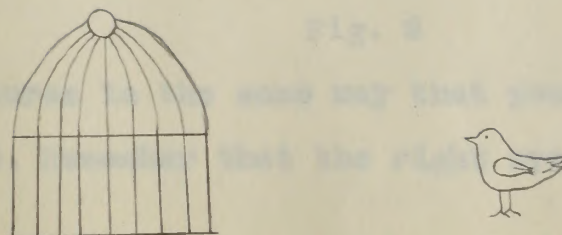


Fig. I

in your eyes, i.e., imagine you are fixating the most distant object possible, and then while holding the eyes unwaveringly in that posture, bring the picture up to a position about six inches before the face, cage in front of the left eye and bird in front of the right, whereupon, the bird will slide into the cage. But at the same time, you may notice from out the corner of your eye, that there is an empty cage on the left and a homeless bird on the right. The inner image of bird and cage came together, while the outer ones remained widely apart. You can remove these outer images from the field of vision by placing a post card edgewise to the nose (while still maintaining the previous fixation) so that it points directly toward the middle of the picture.

The stereoscope uses this principle of double image to give depth perception to pictures. Thus the psychological center of an object is to the left in a right eye picture, and to the right in the left. Figure 2 shows the stereoscopic pictures of a square pyramid whose apex points directly at us. If you do not have a stereoscope handy, combine the

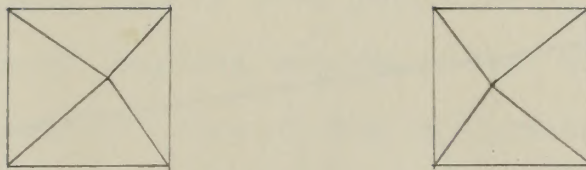


Fig. 2

two pictures in the same way that you made the bird go into the cage. Remember that the right eye sees more of the right

side and the left more of the left side. Now what would be the effect of a stereogram the pictures of which were taken at a greater distance apart than the interocular distance;

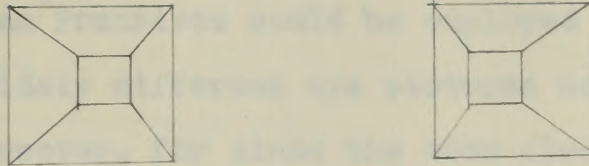


Fig. 3

i.e., if you could see further around both sides of a ball or tree, how would it look? The answer is that it would have greater depth. This new principle is used in the ^{range} gauge finder on warships. Figure 4 contains four mirrors (a,b,c,d) so placed that a and d may receive light from wide distances apart and reflect it into mirrors b and c. Thus the left eye behind mirror b gets the same impression that it would were it located at mirror a etc. It is as if the interocular distance were tremendously increased. Opera glasses and prism

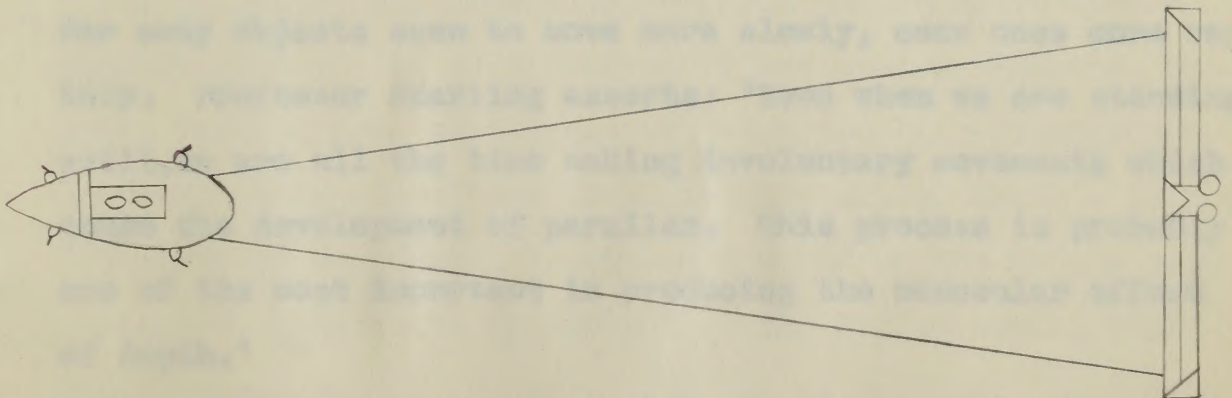


Fig. 4

binoculars employ this same principle.

The moon is not too far away to prevent us from making a stereogram of her globe. Two cameras, one at New York and one at San Francisco could be employed at the same time to get the widely different eye pictures needed. This is not necessary, however, for since the moon always keeps the same face toward us, all we need do is to take one picture at one hour of the night and another from exactly the same position an hour later. The two pictures will readily fuse in the stereoscope and the result will appear like a solid globe on which the dead crater of the moon stands out with remarkable clearness.

Now let us turn to the psychological factors in space perception.

The first of these is called perspective. That is, while looking down a railroad track, the rails seem to meet. This is due to retina stimulation.

A second psychological factor is called parallax by which we may determine the rate of speed between objects. Far away objects seem to move more slowly, near ones more rapidly. Professor Starling asserts: "Even when we are standing still, we are all the time making involuntary movements which cause the development of parallax. This process is probably one of the most important in producing the monocular effect of depth."

Another physiological factor in depth perception is the "haze or changed color which comes with distance. Distant

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objects are hazy, indistinct and blue in color, while near objects are clear and have their own color. The changed color and haze depend upon the amount of air intervening. In a very clear, dry air, estimates of distance are subject to large mistakes on the part of one who comes from a lower altitude and denser atmosphere."

A fourth sign of relative distance is superposition. Objects that hide parts of other objects are evidently nearer than the objects covered. Finally, shadows furnish a means of estimating the relative distance of parts of the same object."

These five psychological factors at times unite with the three physiological factors to operate all at one time. In all cases, the distance that we feel things to be is the result of various stimulations upon our motor mechanism. Distance means reaching out toward; we perceive space as much with our hands and legs as we do with our eyes, since many other muscles other than eye muscles are involved in such widespread responses.

The question now arises, "How accurate are our perceptions of space? The answer is variable and accurate within certain limits. To be conscious of our errors, however, implies that we have some means of measuring our mistakes. This leads to an important law in psychology called Weber's law of illusions of magnitude. It was discovered by the German psychologist, E.E. Weber, accidentally while toying with a blunt pair of compasses. He stated his law as follows: "In comparing objects we perceive not the difference between them, but

the ratio of this difference to the magnitude of the objects compared." This is really a law of inertia. The reactions we make to stimulation all have a certain momentum which, by affecting the succeeding responses, affect also our judgments.

Applied to the perception of space, this law means that even though we are always making mistakes in our judgments of distance, rates of motion, extents, and depths; nevertheless, since we are constantly making the same percentage of error, our relationship to the environment of space remains relatively the same. Thus our errors are uniform, constant, and calculable.

Following are some of the more common illusions of space. The underestimation of a vertical line is universal with the unpracticed eye. In figure 5 the horizontal and vertical distances are the same. The error in estimation is due to eye movement. It requires greater effort to elevate the eyes than to swing them from side to side; thus we base our judgment on expenditure of energy. Another explanation may be offered here also on the basis of empathy, the tendency to feel oneself into the situation.

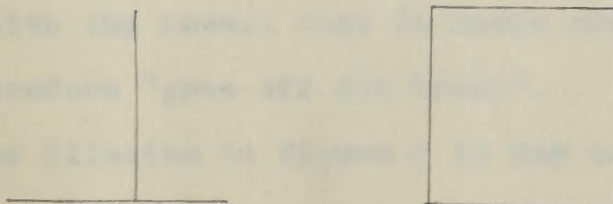


Fig. 5

The value of this difference to the magnitude of the object
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In the case of the square inscribed in the circle: on this theory all acute angles make us feel cramped and huddled, and all obtuse angles make us feel as if we were yawning and stretching. In the case of the square and the circle, we read our own kinesthetic squeezes into the meeting point of arc and cord.

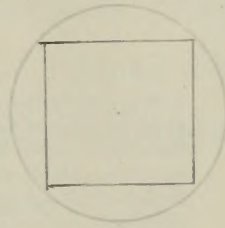


Fig. 6

Figure 7, Poggendorff's illustration is due to erroneous eye movement. The sections of the broken line do not appear to be continuous for the reason that the eye, in reading the

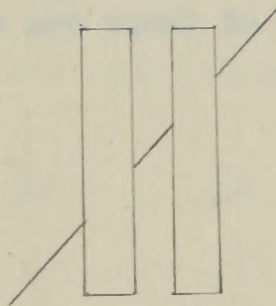


Fig. 7

picture from left to right, leaves the diagonal for the vertical with the result that it keeps moving over to the right and therefore "gets off the track".

The illusion in figure 8 is due to the fact that the eye stops at every line, thereby inducing the judgment of great-

er distance in the direction in which the eye is traveling. As a matter of common observation, "filled" spaces usually appear larger than unfilled spaces. This may be observed in the case of the dots (figure 9) as well as in the case of furnished and unfurnished rooms.

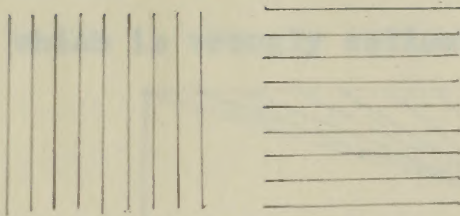


Fig. 8

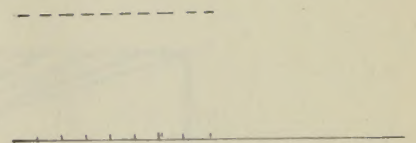


Fig. 9

Figure 10 illustrates the Muller-Lyer illusion. "The two horizontal lines are equal in measurement; they are equal to

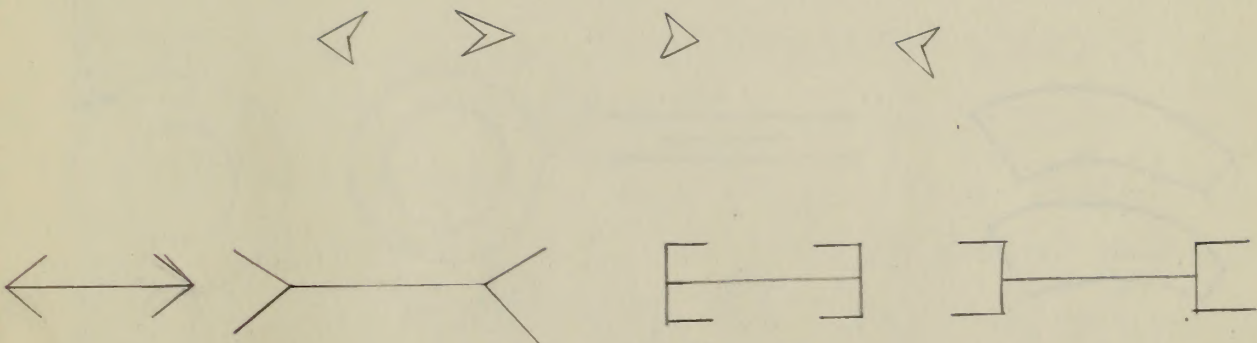


Fig. 10

the eye; why? The suggestion is that the eye moves freely along one and obstructedly along the other. Experiment shows

an increase in the frequency of the eye is observed
 as a result of the increase in the frequency of the
 eye. The frequency of the eye is observed to be
 in the range of the eye (Figure 1) as well as in the case
 of the frequency of the eye.

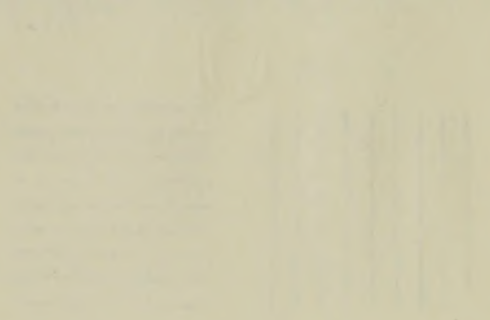


Fig. 8

Fig. 9

Figure 9 illustrates the relationship between the
 frequency of the eye and the frequency of the eye.

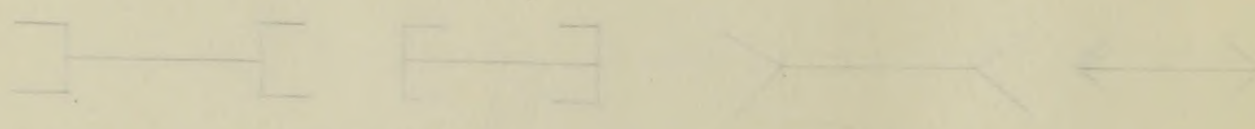
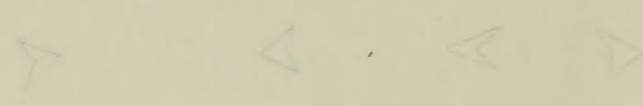


Fig. 10

The frequency of the eye is observed to be
 in the range of the eye (Figure 1) as well as in the case
 of the frequency of the eye.

that movements along the lower horizontal take a longer sweep often coming to a halt only when they have shot beyond the end-points of the line; whereas movements along the upper horizontal are themselves shorter and frequently come to a halt before the extremities of the lines have been reached."

Hering's figure 11 produces an illusion because it contains such a large number of obtuse and acute angles, each of which is wrongly estimated.

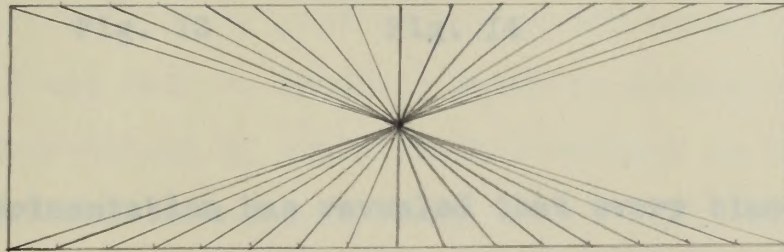


Fig. 11

Some illusions here are due to contrast effects as we take

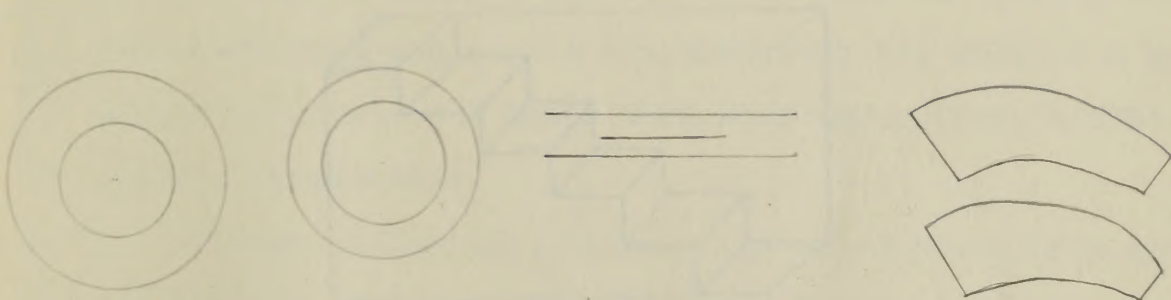


Fig. 12

one dimension as the standard without overcoming the inertia necessary for correction.

A final class of illusions may be said to illustrate our educated and inveterate tendency to see all things possibly

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as if they were space-filling objects. The book (figure 13) as well as the reversible cube (figure 14) and the staircase (figure 15) illustrates this tendency to a marked degree. Pre-



Fig. I3

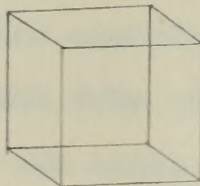


Fig. I4

cise experimentation has revealed that every time these figures appear to change thus to us, our eyes have been moved to fixate a different element of the design, thereby bringing it into the foreground.

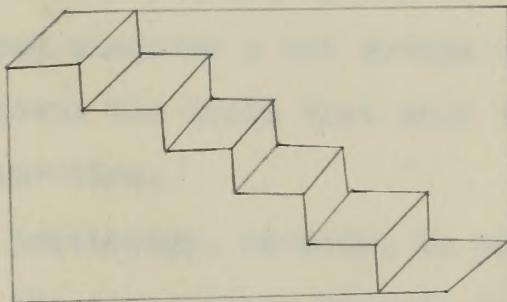


Fig. I5

as it may seem self-evident, the right (figure 13) as well as the perspective view (figure 14) and the elevation (figure 15) illustrate this property in a certain degree, but



Fig. 14



Fig. 13

the explanation has revealed that every line (figure 16) that appears to converge toward a point, even when viewed in perspective, is in fact parallel to the horizon, thereby violating it.

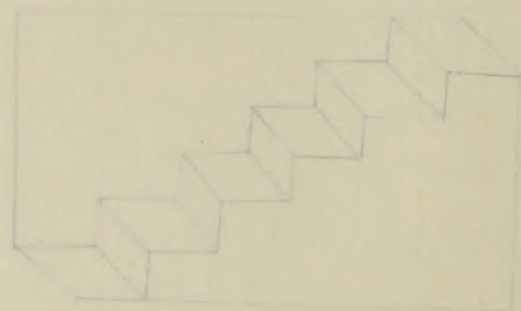


Fig. 16

CHAPTER IV

HOW WE LEARN the ASSOCIATION of IDEAS

Very early in the history of psychology it was recognized that there was a certain definite order and sequence in our thinking, certain laws of the association of ideas. The Greek philosopher, Aristotle, stated four principles to account for the succession of ideas in our minds:

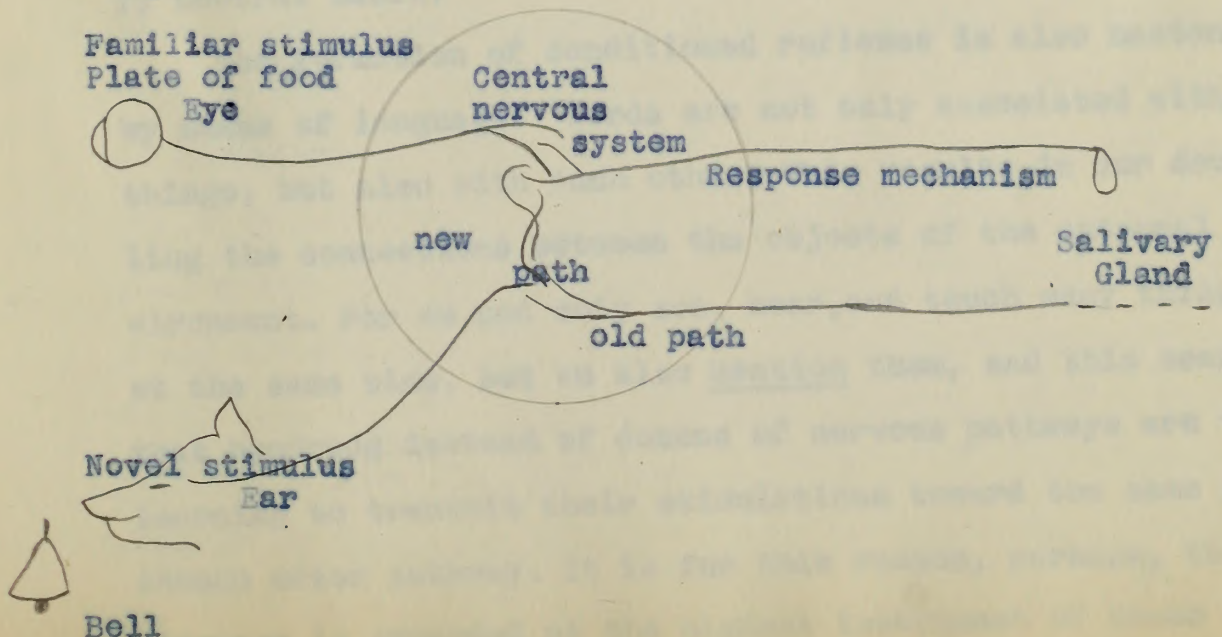
1. Association by similarity, as for example, when upon seeing a stone wall we think of other structures built of stone,
2. Association by contrast, illustrated in the case of the sight of a bankrupt man recalling in our minds his former happier state.
3. Association by succession exemplified in the case of a person, who, being shown a piece of cloth imagines the steps by which it can be made into a garment.
4. Association by contiguity in time and place, a principle employed whenever a hat brings up the idea of a head, a pair of gloves the hands that wear them; fire, smoke; the sunset, supper-time.

Modern psychology, however, is not content with merely classifying the connections between ideas; it wants to know how and where such connections are formed in the first place. And the answer to this question is something as follows: all associations between what are called ideas are originally associations between things, and that these bonds are made whenever we take an active interest in what is going on about

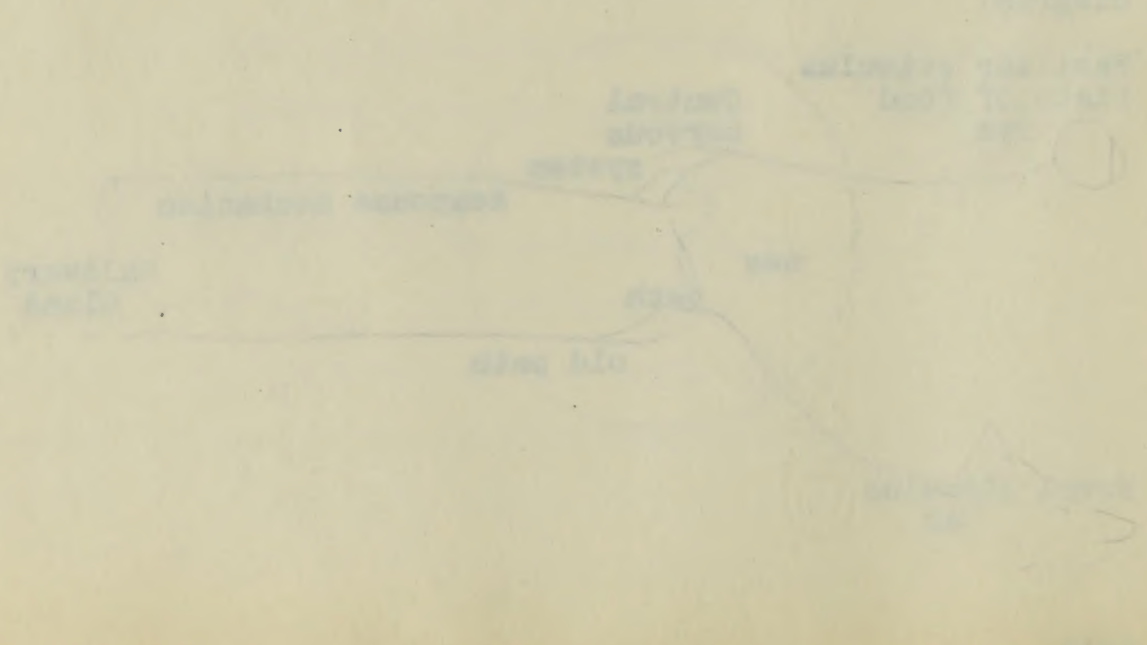
us. As interests differ, so do associations. The word "bark" calls up the word "tree" to a woodman, while it arouses the idea of "dog" to the keeper of a kennel. It is due to our dominant interest, our bias, our temperamental disposition that most of our associations are formed. The mention of the word "stone" brings one sort of association in an architect, another in a knife-grinder, another in a flour-grinder, and still another in a man within prison walls. In this sense, associations are equivalent to habits of thought. The principles enumerated by Aristotle are more or less inadequate since they do not give any reason why ideas of similarity should be awakened in our mind, ideas of difference in another, ideas of succession in a third, and ideas of contiguity in a fourth. Aristotle's laws of associations are rather classifications of all the possible connections between ideas. The kind of mind that he was describing was a mind like his own, a mind with a severely logical bias.

Let us now look at the mechanism by which associations are learned. This mechanism by which associations are learned is called the "Conditioned reflex", and our knowledge of it is due largely to the investigations of the Russian physiologist, N. Pavlov. Professor Bayliss, in his "Principles of General Physiology", gives the following account of the formation of these conditioned reflexes. "A dog, when given food, secretes saliva as is well known. Suppose that every time the food is given, a particular bell is rung. After a number of repetitions of the combination of bell and food, the sound of

the bell alone is found to cause the secretion of saliva." Moreover, it is the sound of this particular bell, not just any bell, that will make the dog's mouth water, for it was shown that if the dog has been accustomed to receive food when middle C was sounded, the note C# was heard without producing any salivary response. A similar conditioned reflex could be produced by the aid of a colored plate. For example, if this particular dog had always been fed from a blue plate, the sight of a blue plate alone would invariably cause the flow of saliva, while plates colored white, yellow or green would evoke no such reaction. We may then state the law of the conditioned reflex: If a new indifferent external stimulus is many times present along with one which has already evoked a definite response, the subsequent presentation of the new stimulus causes the reflex to be given. (The law stated according to Bayliss). The scheme of the nervous connections involved in the formation of an association between the bell and the sight of food may be indicated by the following diagram:



The first thing to be done is to make the connection of water.
The second is to make the connection of the water supply.
The third is to make the connection of the water supply.
The fourth is to make the connection of the water supply.
The fifth is to make the connection of the water supply.
The sixth is to make the connection of the water supply.
The seventh is to make the connection of the water supply.
The eighth is to make the connection of the water supply.
The ninth is to make the connection of the water supply.
The tenth is to make the connection of the water supply.
The eleventh is to make the connection of the water supply.
The twelfth is to make the connection of the water supply.
The thirteenth is to make the connection of the water supply.
The fourteenth is to make the connection of the water supply.
The fifteenth is to make the connection of the water supply.
The sixteenth is to make the connection of the water supply.
The seventeenth is to make the connection of the water supply.
The eighteenth is to make the connection of the water supply.
The nineteenth is to make the connection of the water supply.
The twentieth is to make the connection of the water supply.



The two stimuli acting simultaneously not only gradually wear down the resistance of the synapses in the central nervous system but they also accustom the final common path to respond to either stimulus with equal ease. Hence, when later on only the bell is presented, the salivary reflex takes place as readily as if the plate of food were also shown. In the case of the reflex conditioned by the blue plate, both stimuli, the familiar and the novel, are received through the eye.

The great bulk of the nervous system is in the brain, and the brain is almost wholly made up of connectors, that is association fibers. This accounts for the tremendous number of associations in the individual who is educated. The nervous system is so organized and, especially the brain, is so full of interconnecting pathways that the novel stimuli can be employed to evoke any familiar reaction, provided the connection between the two is made often enough to establish the necessary neutral habit.

The formation of conditioned reflexes is also hastened by means of language. Words are not only associated with things, but also with each other. This results in our doubling the connections between the objects of the external environment. For we not only see, hear, and touch many things at the same time, but we also mention them, and this means that hundreds instead of dozens of nervous pathways are then learning to transmit their stimulations toward the same final common motor pathway. It is for this reason, perhaps, that language is regarded as the highest instrument of human in-

The first object of the present study is to determine the extent to which the results of the present study are consistent with the results of the previous study. The second object is to determine the extent to which the results of the present study are consistent with the results of the previous study. The third object is to determine the extent to which the results of the present study are consistent with the results of the previous study.

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telligence and learning.

All associations are based on this afore-mentioned law. Not only does the sight of the dinner table make us think of eating, but even the menu card on which our favorite foods are mentioned can cause our mouths to water, so fully have our various eating reflexes been conditioned by these novel stimuli. Our whole school education and process of learning consists of the formation of these responses in an orderly manner passing from the familiar to the unfamiliar, and from the simple to the complex. The familiar is connected with the novel by being mentioned along with it, and, due to the frequent repetitions of the connection, association becomes firmly established.

Pavlov's law is then the fundamental law of all thinking. Whatever things have been experienced together or in reasonably quick succession tend to recall each other when only one of them is mentioned. We learn what is new by tying it to something which is familiar, and thus advance in intelligence. The acquisition of a new language is difficult only because so many hundreds of conditioned reflexes have to be formed in so short a time. Moreover, we unify and weld our many experiences together because the novel stimulus always evokes the more familiar reaction. Things always get their meaning from the number of deeply ingrained associations they arouse. Contrariwise, the stimulus which arouses no associations whatever means nothing to us. The learning process is then, the constant interplay between novel stimulations and familiar associations; both are required in

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order that the stream of thought should flow at its normal rate, For, if we learned nothing new, we would be idiots, and if we forgot all that was familiar, we would be demented; it is therefore due to this constant knitting together of experience that we possess any degree of mental unity whatever.

We are now ready to explain what is meant by the word idea. When we say that ideas are associated in our minds, we really mean that we are thinking of absent objects or of stimulations which are no longer present. The word idea is rather a tricky one to define, for, if you will look it up in a good dictionary, you will find that it means a dozen or more different things. But it is psychology in connection with the topic we are discussing that tells us that ideas are really reactions which are carried out without the normal stimulus to such reactions being present. Let us call them "as if" reactions. For example, if I mention the word "apple" and you say you are thinking, i.e., have an idea of the object I mean, you really react as if the apple were present. Likewise, when a person says "I have an idea that it is going to rain," he is then reacting to some degree as he would if rain were falling. Strictly speaking, the noun idea is an unfortunate word, for ideas have no existence independently of themselves. What we should rather say is that we indicate the apple and the rain. In this sense, ideas are equivalent to imaginations, that is, fictions of the mind which represent objects in their absence. All imaginations due then to conditioned reflexes and the so-called "pictures

of fancy" which we produce, are more or less vivid according as the conditioned rearousal of the response is strong and weak, that is, according as the amount of energy we then expend is great or small. There is no sensation without motor response and whenever there is a motor response, we have some form of consciousness as a result. When, then, you say "apple" and imagine the sight of the fruit, the stimulus of your voice arouses much the same motor response as would be produced were the object itself stimulating the retina and that is why you seem to see it before you. For just as the sight of an apple brings up its name, so does its name bring up a faint picture of the object itself. This response may be produced by the motor fibers of the optic nerve upon the sensitive plate of the retina. It is, of course, due to the millions of conditioned reflexes we have acquired that the flow of imaginations in our minds is so continuous.

There are several things which determine which associations shall be formed. One of these is our needs and desires. When left to ourselves, whether in infancy or in middle life, our associations tend to be made on the basis of our spontaneous interests. The child wants to find out the "go" of everything which he sees or handles, and his exploration of the environment leads to the formation of an entirely different set of conditioned reflexes than would be made if he were hampered by restrictions of various sorts. Likewise, the adult person, while off on his summer vacation, makes acquaintances with nature and people that would never be made in the environment of his regular work. Another im-

fluence which establishes associations is our educational system. The books in the public school curriculum are planned for the purpose of establishing habits of thought quite different from those which would be formed without their guidance. Moreover, the author of one text-book in arithmetic aims to build up one sort of associations, while the author of another book on the same subject proceeds to the establishment of another set. A third important factor in determining associations is the influence of other people, such as parents, brothers, employers, political leaders, and so on, from whom we get both early and late in life all manner of influences for the establishment of associative tendencies. Our "home ties" are one and all associations as well as our politics, patriotism, and religion, our aim in life, our philosophy and our "ideal" among the opposite sex. Every mental characteristic we possess may be analyzed into a group of conditioned responses. And as our elementary education forms them, so often our higher education tends to demolish them in order to plant better and more intelligent tendencies in their stead. In fact, civilization may be interpreted as the struggle to establish the more permanently profitable conditioned reflexes in the human race.

The factors that determine which one of the many possible associations will arise at any given moment are usually stated to be four in number: 1. the number of times the association has been made; 2. the recent occurrence of the association; 3. its vividness; 4. our present interest and emotion-

al tone. James writes of the first two of these factors, "Thoughts tend, then, to awaken their most recent as well as their most habitual associations. This is a matter of notorious experience, too notorious in fact, to need illustration. If we have seen our friend this morning, the mention of his name now recalls the circumstances of that interview, rather than any more remote details concerning him. Excitement of peculiar tracts or peculiar modes to general excitement in the brain leave a sort of tenderness or exalted sensibility behind them which takes days to die away. As long as it lasts, those tracts or those modes are liable to have their activities awakened by causes which at other times might leave them in repose. Hence, recency in experience is a prime factor in determining revival in thought." On the subject of vividness James remarks, "If a man in his boyhood once talked with Napoleon, any mention of great men or historical events, battles or thrones, on the whirligig of fortune, or islands in the ocean, will be apt to draw to his lips the incident of that one memorable interview. If the word "tooth" now suddenly appears on the page before the reader's eye, there are fifty chances out of a hundred that, if he gives time to awaken any image, it will be the image of some dental operation in which he has been the sufferer. Daily he has touched his teeth and masticated with them; this very morning he brushed, used, and picked them; but the more rare and more remote associations arise promptly because they were so much more intense."

And of the fourth factor James writes, "The same objects

do not call forth the same associations when we are cheerful as when we are melancholy. Nothing, in fact, is more striking than our inability to keep up trains of joyous imagery when we are depressed in spirits. Storm, darkness, war, images of disease, poverty, and dread, afflict unremittingly the imaginations of melancholiacs. And those of sanguine temperament, when their spirits are high, find it impossible to give any permanence to evil forebodings or to gloomy thoughts. In an instant the train of associations dance off to flowers and sunshine and images of spring and hope. The records of African or Arctic travel perused in one mood awaken no thoughts but those of horror at the malignity of nature; read at another time they suggest only enthusiastic reflections on the indomitable power and pluck of man."

It is, however, apparent that if there are so many factors controlling both the formation and the reappearance of associations, mind is much more complex than the naive person might suppose. And indeed, the longer one studies the mind and the deeper one probes into its workings, the more complicated does one find it to be. Nevertheless, the complexity with which we meet is all a complexity of detail,--the fundamental facts and laws and the underlying principles we have previously enumerated hold from first to last.

chapter v

THE PLEASURE and REALITY PRINCIPLE

The pleasure principle represents the primary original form of mental activity, and is characteristic of the earliest stages of human learning and development, both in the individual and the race. Therefore, it is found in its typical expression in the mental life of the infant and to a less extent in the savage. Its main attribute is a never-ceasing demand for immediate gratification of desires that give pleasure to the unconscious regardless of cost or consequence. Thus it may be said to be egocentric, selfish, personal, anti-social.

The infant illustrates in a very observable manner the existence of the pleasure principle as the basic motive for all its actions. Nothing but his own desires concern him, and he demands with unqualified insistence their fulfillment in the shape of food, warmth, petty attentions, and any object that may come to his notice.

But while the infant offers the most perfect example of the pleasure principle in operation, because it works through him with no disguise, it can be noted more or less prominently among all people. No individual is free from this trait. It is, of course, good that this is so or life would be more dull and drab than it is at its worst.

A normal, well-rounded personality is one in which all the basic characteristics are present in the proper degree, one balancing the other, thus preserving a desirable equilibrium. But as we so well know, not everyone is in this fav-

The American Political System

The American political system is a complex and dynamic one, shaped by a variety of factors including geography, history, and culture. It is a system that has evolved over time, adapting to the needs and challenges of its people. The system is based on the principles of democracy, which are enshrined in the Constitution. The Constitution is the supreme law of the land, and it defines the structure and powers of the federal government. The federal government is composed of three branches: the executive, the legislative, and the judicial. Each branch has its own responsibilities and powers, and they all work together to govern the country. The executive branch is headed by the President, who is elected by the people. The legislative branch is composed of the House of Representatives and the Senate, which are also elected by the people. The judicial branch is headed by the Supreme Court, which is appointed by the President and confirmed by the Senate. The system is designed to ensure that power is not concentrated in any one branch, and that the rights of the people are protected. The American political system is a unique one, and it has played a significant role in the development of the world. It is a system that has inspired many other countries, and it continues to evolve and adapt to the needs of its people.

ored category. Leaving aside those who are the victims of so outrageously pernicious environment that any approach to normal life is impossible, there are still countless numbers of people in all walks of life who fall short, some seriously so of this standard.

These unadapted people, some fitting like the proverbial square peg in a round hole, have never learned to adjust themselves. It has not been their fortune to learn how fallacious is the policy of following the pleasure principle along some line of least resistance to the point of excess.

People who maintain their grip on reality avoid the alluring pitfalls to which undue surrender to the pleasure principle leads. Where the temptation is strong, there are often elaborate precautions taken to escape the dreaded fate. This is true when the exact situation is not consciously realized and when the precautions are the result of instinctive rather than logical effort.

Primitive man offers an excellent example. He has erected an intricate set of taboos to avert the consequences of his fierce self-seeking impulses. He realizes vaguely there are inexplicable inner forces pulling him this way and that. He does not know what these emotions are, nor why nor whence they come, but senses the danger in their dominance.

We have only to study our dreams, phantasies, and often unreasonable emotions of jealousy, vanity, etc., and our tendency not to face reality, or our disinclination to recognize the facts when they are displeasing.

Thousands of years of civilization with the accompanying

development of cultural, ethical, religious, and social factors have done much to modify and adapt the power of this pleasure principle, but no amount of civilization can eliminate or crush this dynamic force.

As a matter of fact, the objection is that our civilization is becoming so constantly ramified by scientific achievements, mechanical inventions, and natural discoveries, etc., that we can hardly adapt our primitive, slow evolving characteristics to the more rapidly changing environment. And this condition is intensified because as a social unit we have preferred to avoid any serious discussion or study of psychic phenomena so as better to cope with the problems that confront us.

The reality principle, to all intents and purposes, is the antithesis of the pleasure principle. They are both present in all of us all of the time. The condition which makes us either "normal" human beings or neurotic misfits in society is largely governed by the proper balance on the one hand or the lack of relative proportion on the other of these two principles in our psychic make-up.

Directly as they manifest themselves in our Unconscious, these two principles are ever exerting their respective influence. Freud has described the reality principle as having for its function the adaptation of organism to the exigencies of reality--that is of the world animate and inanimate, which lies outside and around every individual. It is evident that if the individual were not capable of acting upon the reality

principle to a very large degree throughout life, he would as a consequence be unable to exist. He must realize the uncompromising force of sea, air, gravity, fire, in order to maintain life. He must learn the claims, needs, and superior force of his fellowmen, even in the most primitive society or community. Thus by the very act of living, even without definite instruction to that end, we are learning consciously and unconsciously a working knowledge of the reality principle. It is exemplified in the old adage of "learning by experience" rather than by hear-say or by being told.

Sometimes, as we all know, this is a very painful way of learning, although its effectiveness is unquestioned. The child who puts his hand on a hot stove is learning by a very drastic method to adapt himself to reality.

The development of the reality principle is through the channels of reason. Those who are the most logical and of the most rational turn of mind best exemplify the reality principle. This principle is expressed in directed thinking in contrast to the phantasying and intuitive expressions of the pleasure principle.

It is the inevitable conflict between these two great principles in our psychic make-up which is the cause of repressions; and repressions which become so severe that they cause serious disharmony in our Unconscious, result in a neurosis.

As to pain and pleasure, there is no other sense that has been endowed with such a profound significance for the

life of man as has the sense of pain. From time immemorial it, of all the senses, has been taken as the index of disease and the forerunner of death, while the most elaborate incantations, the most fervent prayers, and the greatest scientific acumen of which man is capable have been devoted to its alleviation and relief. Indeed pain is the only sense which has an equally important place in medical science, ethics, philosophy, and religion. Pain and evil have an inseparable connection.

The religious philosophers of India begin by calling pain the fundamental fact of human life and they devote all the remainder of their systems to its explanation, and devise their religious rites for its atonement. Contrariwise, one of the fundamental doctrines of Christian Science is the absolute unreality of pain which is held to be the fabrication of an erring mind.

The importance which is thus attached to pain is not to be wondered at, since pain is unique among all the senses. In the first place, there is no specially modified receptor organ for pain. For while there are rods and cones in the retina, the organs of Corti in the ear, taste buds on the tongue, and tiny corpuscles of various shapes for the reception of touch, warmth, and cold, the only receptors for pain are the free nerve endings--the dendrites of the sensory neurones themselves. In the second place, there is no special switch-board or "center" in the brain as there is for sight, hearing and the other senses. Again, pain is produced by a greater

variety of stimuli than is any other sensation. For not only will the merest contact of a needle point on the surface of the skin above a pain spot produce the wiry thrill that is called skin pain, but all high intensities of stimulation in the other sense fields are equally painful. Too much light painfully blinds us, too much sound painfully deafens, the first whiff from an ammonia bottle is painful just as intense heat or cold is painful. In fact, until a comparatively few years ago, pain was regarded even by scientists as only a superstimulation of any of the senses. Moreover, the electrical current is invariably painful no matter to what sensitive surface of the body it is applied. We seem to have developed no organ for the reception of electricity as we have for the other forms of the energies of nature, such as light, sound, and temperature. And besides all this, some of the organs of the body, such as the cornea, the eardrum, and the pulp of the teeth always produce the pain response when stimulated.

We can best understand the mechanism of pain through a consideration of its biological importance. To begin with, pain is really a warning to us that some parts of our bodies are injured or out of function. But not all parts of the body give such a warning. For while the accumulation of toxic products, inflammations and burns, tumors and hemorrhages, the strong or prolonged contraction of a hollow organ, and even such sudden alterations of the blood-pressure as follow the removal of a tourniquet, all produce pain, yet

many other equally important and dangerous stimuli may be absolutely painless. The deeper viscera of the abdomen and thorax are insensible to pinching, cutting with sharp instruments or other mechanical, chemical or thermal stimuli. Likewise, while surgeons find that the membranes of the brain are very sensitive to mechanical injury, especially to stretching and pulling, yet the brain substance itself is quite insensible to pain from either mechanical or chemical stimulation. Similarly, tuberculosis of the lungs is painless while intense pain is associated with tuberculosis of the hip. The sense of pain, then, does not warn of every danger to which the body is exposed.

Here then, we have the clues to both the specific response requisite for pain and to its biological significance as well. It will be observed that pain is felt most in the extremities and on the unprotected surfaces of the body. Now these parts consist principally of muscles. The response which turns stimulations into painful sensations must, then, be principally a muscular response. What evidence is there of this truth?

In George W. Crile's "A Mechanistic View of War and Peace" occurs the following account of the place of pain in the fighting soldier's experience: "Pain as a phenomenon of war exhibits several variations of great interest, the key of which is found in the conception of pain as a part of an adaptive muscular action. Identical injuries inflicted under varying conditions yield pain of unequal intensities. The most

striking phenomenon exhibited by soldiers in the absence of pain under the following conditions: (a) In the midst of a furious charge the soldier feels no pain if wounded; and sore and bleeding feet are noticed not at all. In the overwhelming excitement of battle, he may be shot, stabbed, or crushed without feeling pain. (b) The blow of a high velocity bullet or projectile accompanied by the heat of battle causes no pain or impact, though there may be a burning sensation at the point of entrance and the soldier may feel as if he had been jarred or struck. Frequently he first learns of his wound from a comrade. (c) In the state of complete exhaustion in which loss of sleep is the chief factor, pain is quite abolished."

Now what is happening in the body of such a soldier to prevent the registration of painful feelings? The answer is two-fold. In the first place, the final common pathways of motor discharge are all preoccupied. In telephone parlance, "somebody has the line". And in the second place, there is no energy left to be released and transmitted along those pathways which would function pain if they were ready to be set into operation. But what sort of response would be generated if such pathways did finally become active? The answer is that some defensive muscular activity would be set going, some muscular tension would be established in the wounded part, such as are plainly manifest in colic, in the wrinkling of the brows and the drawing of the face in toothache and neuralgia, and in the tense twitching of the limbs generally when severe pain is felt. That is the response to

pain, the muscular activity without which pain cannot be felt.

Crile continues: "During the overwhelming activation in a charge, the stimulus of the sight of the enemy is so intense that no other stimulus can obtain the final common path of the brain, the path of action. Therefore, if a bullet wound is at the moment when the injury cannot obtain possession of the final common path, it can excite no muscular action and therefore no pain. Hunters attacked by wild beasts testify to the fact that the tearing of the flesh cannot dispossess the excessive activation of the brain by the realization of danger. For this reason, the teeth of the beast do not cause any adaptive muscular response and there is no pain. Not only in war does emotion overcome pain; so does great anger and the exaltation of religious fanatics in their emotional rites."

All this throws additional light upon the biological significance of pain; for since muscular action is essential to pain, we feel pain from those injuries which are reduced either by rest or by muscular rigidity. Cramps, then, are not only painful, they are the body's own automatic "first aid" measures to bring relief to the overworked or injured part. Similarly with headache; its function is to bring us prostrate in order that rest and recuperation may ensue. Pains, then, are not only warning signs, but they are also devices for enforcing rest and hastening a cure.

The fact that harmful stimuli cannot produce pain unless they can get control of the final common path furnishes a useful hint for applied psychology. A person in a dentist's

chair may protect himself from pain by either of two methods; i.e., make the body as rigid as possible and clutch the arms of the chair with force thereby drawing off as much energy as possible; no energy will then be left and no motor pathways available with which to register pain from the teeth; or else sustain muscular flabbiness and collapse so that no harmful stimuli can arouse any muscles to register those tensions and defensive movements which are required for the pain response. We may also get a hint for applied psychology from the fact that the latent period of pain is very long. For of two stimulations given at the same time, one of them painful and the other some strong auditory or visual stimulation it is more than likely that the pain stimulation will get to the spinal cord later than the other, and will find no motor pathway open. Consequently no pain will be felt. Parents and nurses make use of this fact in dealing with young children who fall down and hurt themselves. They pick up the child and distract it as much as possible by agreeable stimulations which occupy all the available motor outlets and thus prevent the feeling of pain.

It is customary to contrast pain with pleasure, but it must be born in mind that pleasure is not a sensation. It is rather a quality that may be attached to any sensation, even under abnormal conditions, as for example, to that of pain. Nevertheless, it is no accident that pain and pleasure are regarded as correlative. For just as pain normally signifies some disaster to the body, so pleasure signifies that the whole kinetic system is expending energy at a rate and in a manner that are well within its capacity to maintain.

SUMMARY

1. The brain is an instrument for regulating and perfecting our mental functions. It is the instrument which guides man's energies and harmonizes his many efforts. If the central nervous system were to be analyzed we would be able to identify the structural units. Such structural units of the central nervous system are called neurones. Functionally it is regarded as a part of a mechanism for transmitting impulses. We may add to this, that the nervous system is also a mechanism for the release of energy in response to sensory stimulation.
2. The mental life of man has well been called one long learning process. this process starts long before birth. As early as the second week of embryonic life evidences of the nervous system are present. In fact no other part of the body is so well marked at this time. All of this brain and nerve formation has to be laid down in the protoplasm before energy can be transformed into energy---in a word, before we can learn. Let us now consider some of the first things the infant learns.
3. First, how do we learn to breathe? Breathing seems to us such a natural activity that little consideration is given to the mechanism by which this function is started. One of the most profound changes occuring at birth is that of temperature. That, and the difference in the surrounding air pressure---in a word, the shock of being plunged into a different medium and being enveloped by new pressures---are the stimuli to breathing. Altho breathing

THEORY

1. The brain is an instrument for receiving and processing
sensory information. It is the central organ of the
nervous system and coordinates the body's activities. It
controls the body's movements and maintains its internal
balance. The brain is also the seat of the mind and
consciousness. It is the organ of the soul.
The brain is divided into two main parts: the cerebrum
and the cerebellum. The cerebrum is the larger part
and is responsible for the higher functions of the
brain, such as thought, memory, and emotion. The
cerebellum is the smaller part and is responsible for
the lower functions, such as balance, coordination,
and reflexes. The brain is also divided into four
lobes: the frontal lobe, the parietal lobe, the
temporal lobe, and the occipital lobe. Each lobe
has its own specific functions. The frontal lobe is
responsible for the planning and execution of voluntary
movements. The parietal lobe is responsible for the
sense of touch, temperature, and pain. The temporal
lobe is responsible for the sense of hearing and
balance. The occipital lobe is responsible for the
sense of sight. The brain is also connected to the
spinal cord, which is the main pathway for the
transmission of nerve impulses between the brain and
the rest of the body. The spinal cord is also
divided into segments, each of which controls a
specific part of the body. The brain and spinal
cord together form the central nervous system. The
peripheral nervous system consists of all the other
nerves in the body. These nerves carry the nerve
impulses from the central nervous system to the
muscles and glands. The brain is a very complex
organ and its functions are still being studied
today. It is the most important part of the body
and without it, life would be impossible.

is chiefly a physiological phenomenon and is concerned much more with life than with mind, yet, since all emotional disturbances and many defects of speech are registered in the breathing its importance for psychology is at once clear.

4. Secondly, how do we learn to swallow?

A slightly new type of nervous activity is involved in learning to swallow. There are not only sensory and motor nerves for each oesophagus ring but there are also sensory and motor pathways leading from ring to ring. So precise do the function of synapse and neurone become with practice that the presence of food in the upper part of the oesophagus automatically starts a wave of contraction down the whole tube. Such an automatic succession of contractions is called a chain reflex.

5. The Grasping Reflex.

This is one of the earliest tendencies we possess. Whether this instinctive action is a relic of the tree life of our simian ancestry is a question too difficult to be decided here. The point for us is that it is a purely spinal reflex and does not involve the brain at all. We have therefore, three causes of the strength and tenacity of the grasping reflex. The first is the great number and strength of the flexor muscles, the second is the circular reflex, and the third is the pre-natal practicing by which the reflex is developed and perfected.

6. Another of the first things we learn to do is to fixate ob-

jects with our eyes. A light streams diagonally into the baby's eye and stimulates it, producing thereby discomfort. The baby at once seeks to get rid of the light until, by turning this way and that, the light strikes the bovea, whereupon he ceases his squirming. It is thus by drawing from the light in the first place that we later learn to use the light to best advantage. The adult turns his gaze not only upon whatever he wishes to read and examine, but also upon the source of every sound, swell and movement which attracts him. This turning of the eye upon the stimulus, moreover, is what is ordinarily meant by the word "attention".

7. How we learn the perception of space.

The ability to perceive space relations comes by dint of long training. The first hint of near and far come quite early in life. The infant soon begins to explore his own body. Upon rolling his head to the right, he sees one sort of thing while at the same time losing sight of others. This starts a faint trace of the meaning of here and there in his mind. and so on through a long list of gestures, looks, postures. Following are several theories on this point.

a. The genetic theory is that of the English Associationist School represented by Locke, Hume, Hartley, James Mill and Alexander Bain.

b. Wundt tried to improve the above theory by (1) giving more recognition to the principle of creative synthesis and (2) by postulating a greater variety of the adjuvant sensations which were supposed to enter into the synthesis.

c. James rejected the Associationist theory stating that

looks like an eye. A light is seen dimly in the
dark, the eye is looking at, looking at, looking at.
The eye is now looking at the eye of the eye, by
turning this eye and head, the light enters the eye, when
upon the object is appearing. It is then by looking from
the light in the first place that we later learn to use the
light to best advantage. The whole scene is now not only
upon whatever we wish to look and examine, but also upon
the scene of every sound, smell and movement which attracts
the eye. This turning of the eye upon the object, however, is
what is ordinarily meant by the word "attention".

7. How we learn the perception of objects.

The ability to perceive space relations comes by dint of
long practice. The first kind of space and eye relation
early in life. The infant soon begins to explore his own
body. When rolling his head to the right, he sees one part
of his body at the same time looking right at objects. This
leads to a false sense of the position of parts and space in his
mind. And so on through a long list of gestures, looks, and
other, followed by several theories on this point.

8. The general theory is that of the English associationists
about perception of light, sound, touch, taste, smell and
temperature.

9. It is said to involve the sense theory by its giving
more prominence to the principle of selective attention and
(10) by postulating a greater variety of the adjustment of
senses which were supposed to enter into the synthesis.
11. James rejected the associationist theory chiefly on the

there are but three kinds of theory possible concerning space.

d. Hermann Lotze has given the best statement of the "psychic stimulus" theory by the use of the term "local sign". Lotze's local sign is, then, not a sensation; it is purely a nervous process initiated by the stimulus to the retina, its specific nature depending upon the locality of the retinal spot stimulated. We perceive space by means of only four senses: sight, hearing, kinaesthesia, and touch. Smell, warmth, and cold may give us direction, but all other senses are entirely spaceless.

8. How we learn the association of ideas. The mechanism by which associations are learned is called the "conditioned reflex". Thus two stimuli acting simultaneously not only gradually wear down the resistance of the synapses in the central nervous system but they also accustom the final common pathway to respond to either stimulus with equal ease. The formation of the "conditioned reflex" is also hastened by language for words are not only associated with things but with each other. Pavlov's law is then the fundamental law of all thinking, for, whatever things have been experienced together or in reasonably quick succession tend to recall each other when only one of them is mentioned. The factors that determine which one of the many possible associations will arise at any given moment are usually stated to be four in number.

1. The number of times the association has been made, 2. the recent occurrence of the association, 3. its vividness,

There are two main lines of thought possible concerning

these.

1. The first line has been the basis of the

"positive scientific" theory of the "local

theory". It is a local theory, not a general one; it

is merely a narrow process limited to the relation to

the relation, the scientific process depending upon the local-

ity of the relation and the relation, the positive theory of

these of this local theory, which, however, is

and which, finally, which, and which may give an illustration

and all other things are entirely neglected.

2. Now we have the association of ideas. The association by

which associations are formed is called the "conditioned

reflex". It is the reflex which is not only

conditioned but also the conditioned of the reflexes in the

conditioned reflexes and the reflexes which are

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conditioned by the reflexes and the reflexes which are

4. our present interest and emotional tone.

9. The pleasure and reality principle. A normal, well-rounded personality is one in which all the basic characteristics are present in the proper degree, one balancing the other, thus preserving a desirable equilibrium. People who maintain their grip on reality avoid the alluring pitfalls to which undue surrender to the pleasure principle leads. Thousands of years of civilization with the accompanying development of cultural, ethical, religious and social factors have done much to adapt the power of this pleasure principle, but no amount of civilization can eliminate or crush this dynamic force. The reality principle is the antithesis of the pleasure principle. They are both present in all of us all of the time. The condition which makes us either "normal" or neurotic misfits in society is largely governed by the balance between the two. As to pain and pleasure; there is no other sense that has been endowed with such a profound significance for the life of man as has the sense of pain. It is customary to contrast pain with pleasure, but it must be borne in mind that pleasure is not a sensation. It is rather a quality that may be attached to any sensation. Nevertheless, it is no accident that pain and pleasure are regarded as correlative. For just as pain normally signifies some disaster to the body, so pleasure signifies that the whole kinetic system is expending energy at a rate and in a manner that are well within its capacity to maintain.

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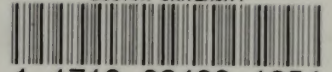
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